

A microscopic view of various bacteria, including green rod-shaped bacteria, orange spherical bacteria, and blue rod-shaped bacteria, set against a pinkish background.

Bacterial Metabolism

Bacterial Metabolism

- Metabolism The sum total of all chemical reactions & physical workings occurring in a cell

Bacterial Metabolism

- Advantages of bacterial metabolism to our environment
 - Original development of O₂ in atmosphere
 - Availability of elemental Sulphur
 - Flow of Nitrogen
- Commercial exploitation of bacterial metabolism has given us
 - Ethanol
 - Other alcohols
 - Acids resulting from fermentation

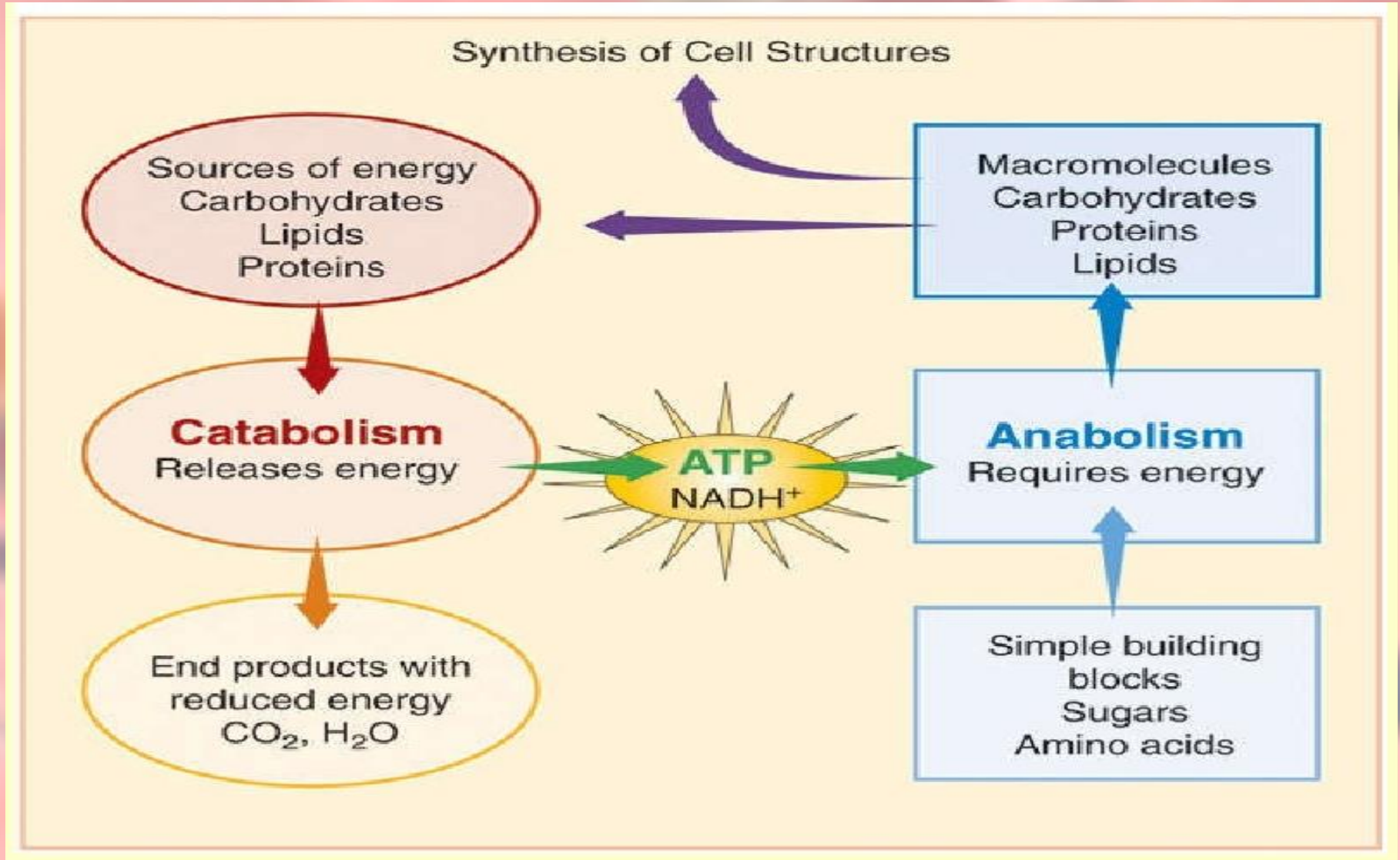
Bacterial Metabolism

- **Basic chemical reactions**
 - A. **Anabolism and Catabolism**
 - B. **Oxidation and Reduction reactions**
 - C. **ATP production and Energy storage**

A. Anabolism and Catabolism

- **2 types of metabolism**
 - **Anabolism - biosynthesis**
 - **Catabolism - degradation**

A. Anabolism and Catabolism



A. Anabolism and Catabolism

- **Anabolism**

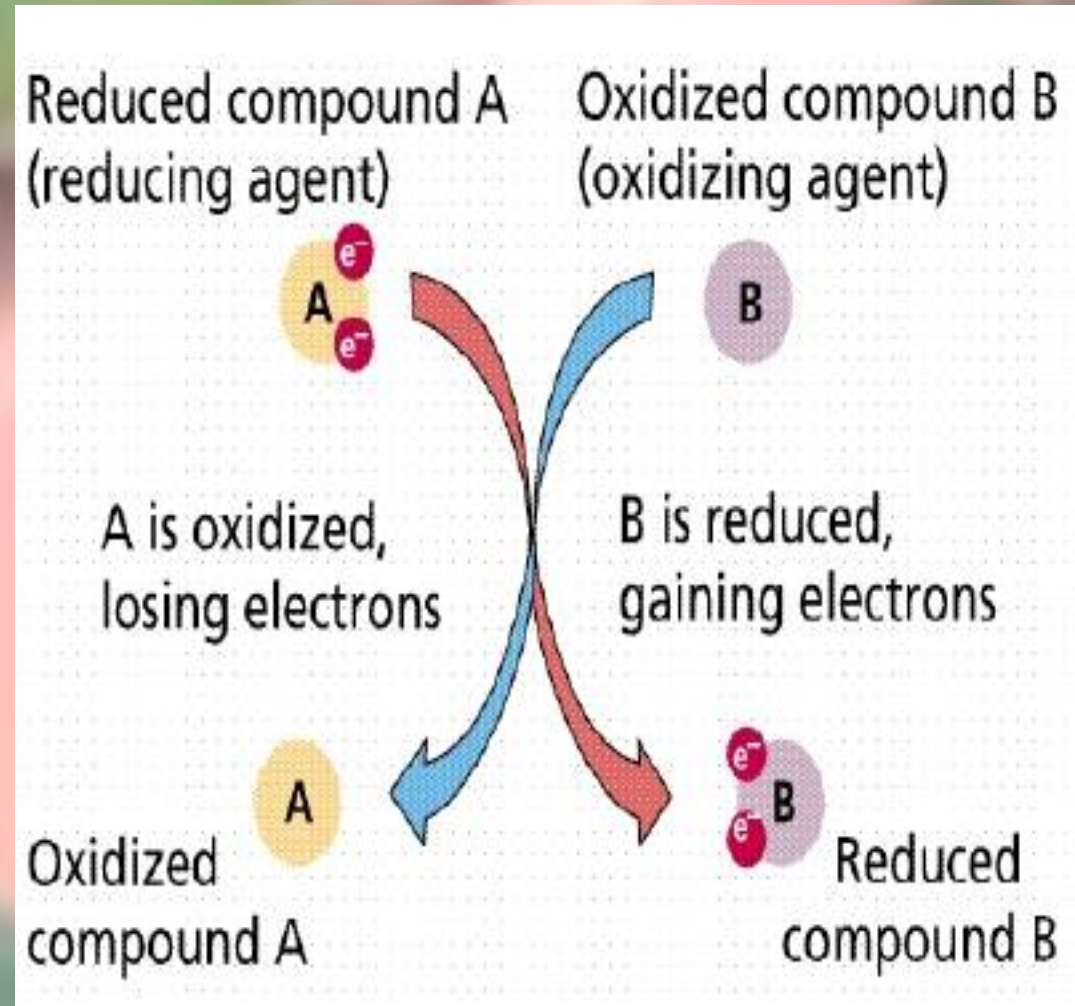
- Organisms catabolize carbohydrates as the primary energy source for anabolic reactions

- **Catabolism**

- Glucose catabolized by
 - Aerobic cellular respiration
 - Anaerobic respiration and Fermentation

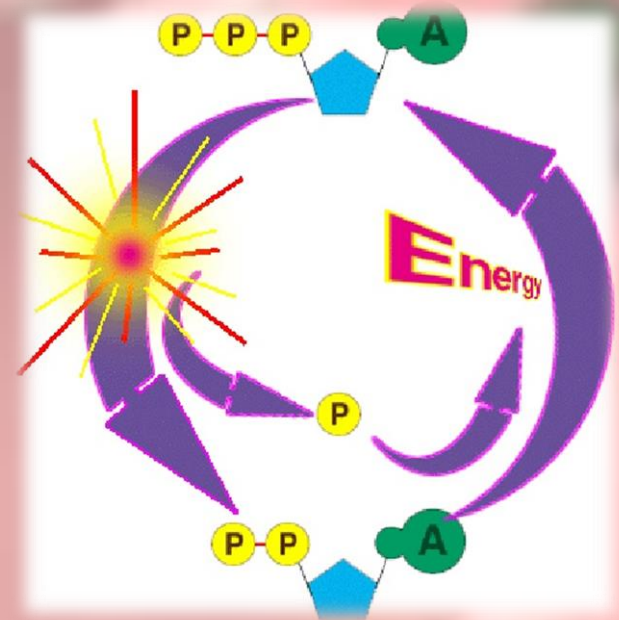
B. Oxidation and Reduction reactions

- **Redox reaction**
- **Oxidation**
- **Reduction**



C. ATP production and Energy storage

- Phosphorylation An organic phosphate is added to substrate
- Energy storing nucleotide



Bacterial respiration

- **Aerobic**

- Final electron recipient in oxidation process is molecular oxygen

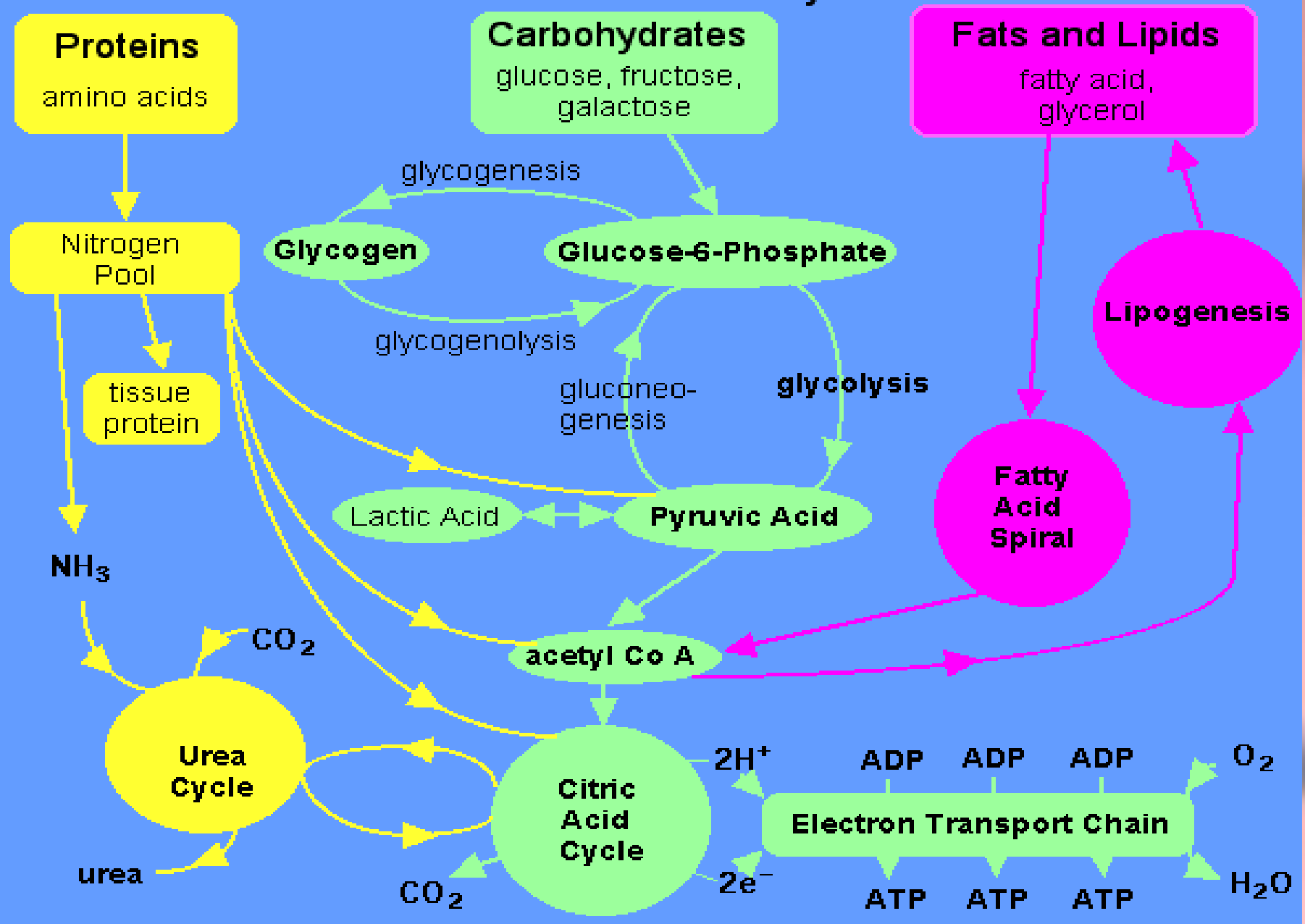
- **Anaerobic**

- Final electron recipient is an organic molecule
- Fermentation
- All bacteria in evolution were anaerobes

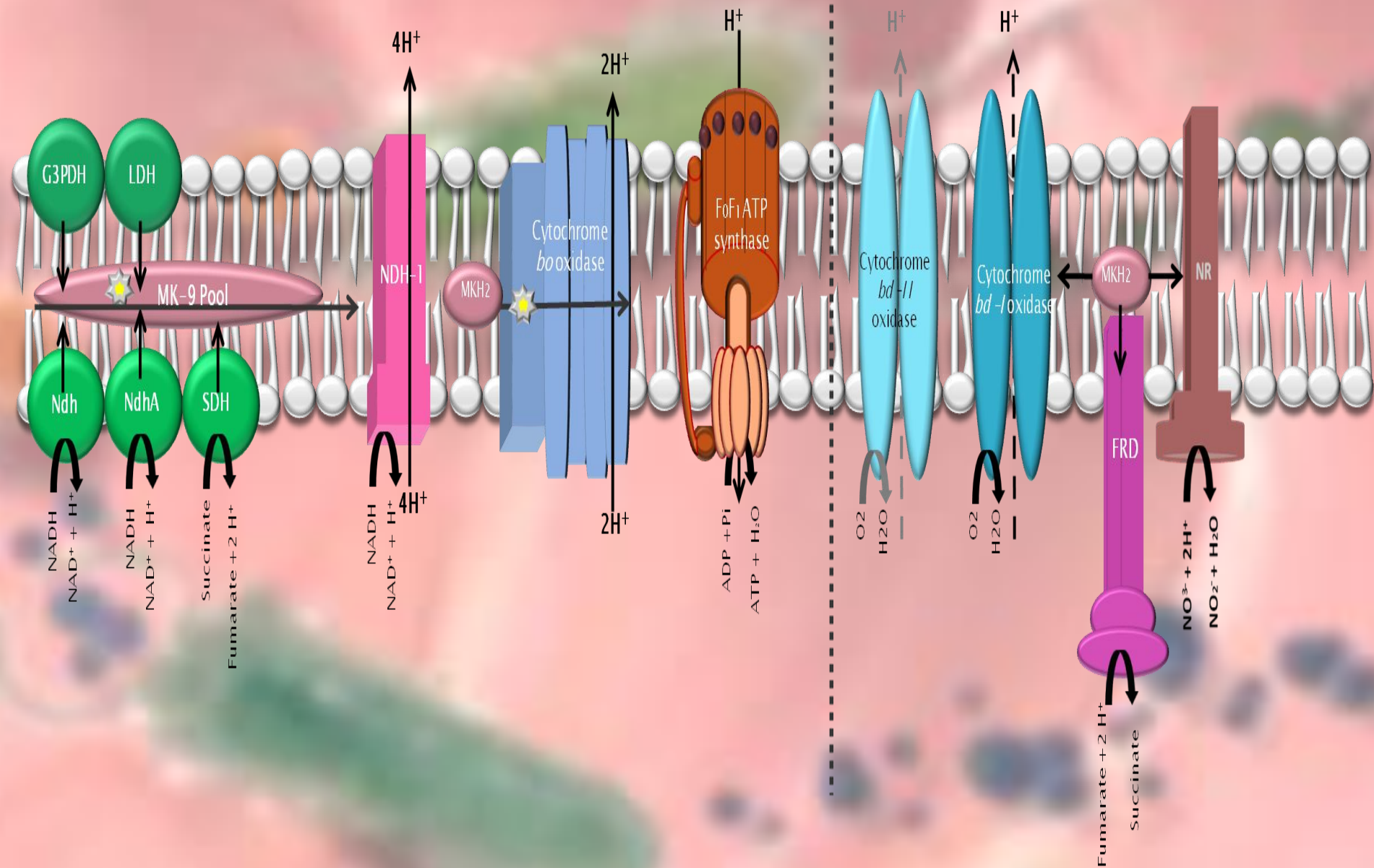
Bacterial respiration

- **Aerobic cellular respiration**
 - Utilizes glycolysis, synthesis of acetyl CoA, Krebs' cycle, and electron transport chain
 - Total molecules of ATP

Metabolism Summary



Alternative terminal oxidase pathway



Bacterial respiration

- Using oxygen in metabolism creates toxic waste
 - Superoxide (O_2^-), Hydroxyl (OH^-) and Hydrogen peroxide (H_2O_2)
 - Microbes produce two enzymes to detoxify
 - Catalase
 - Superoxide dismutase (SOD)

Adaptive responses

- In response to environmental changes (stimuli), different sets of proteins are produced in the exponential and stationary phases of growth cycle
- Each different stimulus leads to a specific adaptive 'stress response'

Adaptive responses

- **Different stresses:**
 - Heat shock
 - Acid stress
 - Oxidative and pH stress are provided by the hostile environment of phagolysosomes
 - Osmotic stress
 - Cold shock
 - Nutrient limitation
 - Anaerobic environment

Global regulatory systems

- Specific control mechanisms
- **Stimulon**
 - All those genes whose expression is increased or decreased by a specific external stimulus
- **Regulon**
 - All those genes under the influence of a specific regulatory protein. There may be several regulons in one stimulon

Global regulatory systems

- specific control systems ensure that the organism synthesizes specific proteins as per the stress
 - Virulence factors
 - Chemicals secreted by an organism can themselves act as regulatory stimuli to individuals of the same species

Bacterial viability

- The ability of a cell to form a colony on an appropriate agar medium
 - The colony count provides an accurate measure of viability

Bacterial viability

- The ability of a particular cell to grow and undergo binary fission, and its progeny would have the same potential
- **VNC (viable but non-culturable)**